Supplementary Material for Chemical Communications

A Fresnel zone plate biosensor of signal amplification with enhanced signal-to-noise ratio

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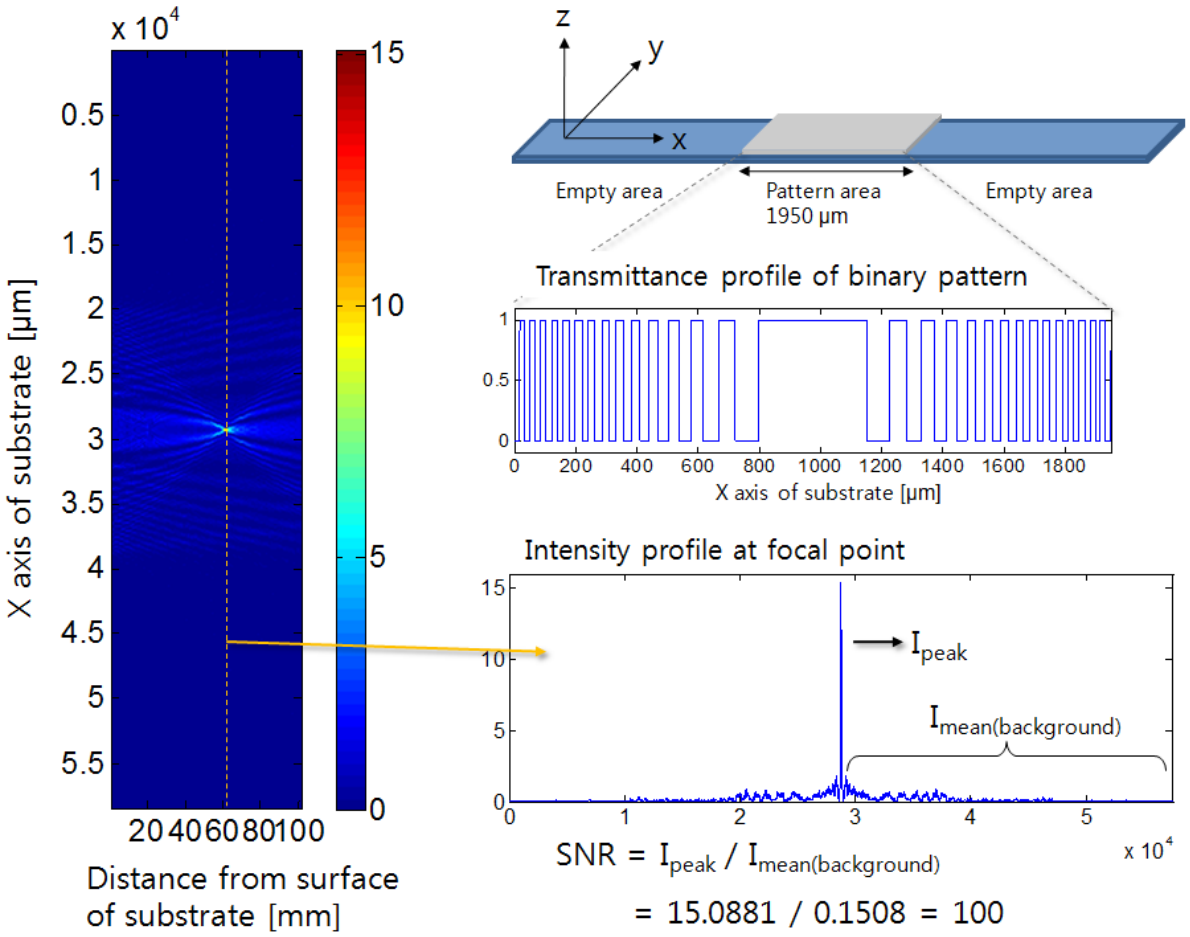
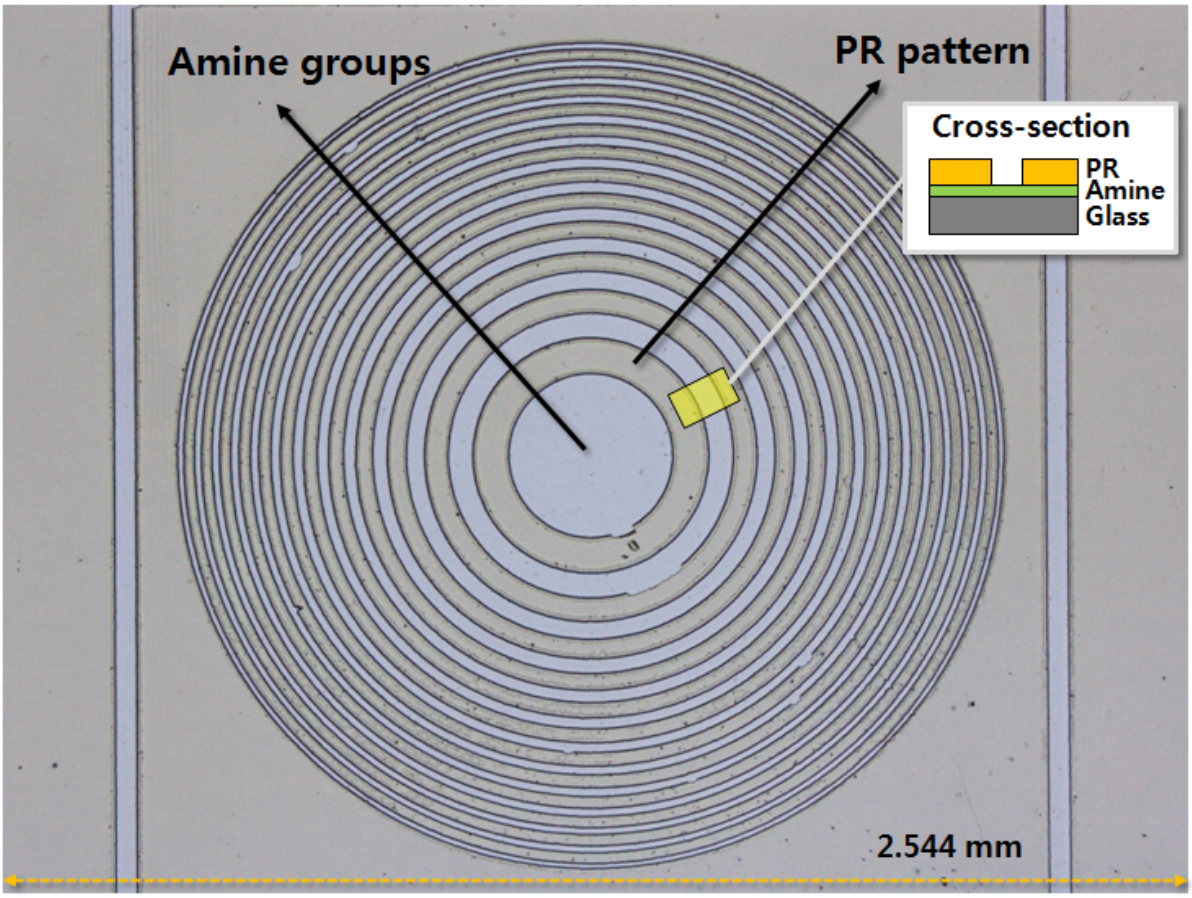
Fig. S1. Theoretical expectation of SNR of binary-amplitude FZP (Fresnel zone plate)



In order to calculate the theoretical value of SNR (signal-to-noise ratio), we conducted simulation of wave propagation of thin binary-amplitude FZP. The FZP was designed to have a focal length of 60.2 mm at a wavelength of 532nm, of which ideal profile of transmittance is shown Fig. S1. We assumed that the virtual FZP pattern was placed between free spaces to exclude any other noise. The wave propagation is presented in the left side, which shows light converging at a pre-designed point. By dividing the intensity of 1st order diffraction beams by an average intensity of background noise, it revealed that 100 of SNR could be obtained at the focal plane.

Fig. S2. Microscope image of FZP pattern of PR after developing



We observed PR pattern by using a microscopy after photolithography. It is obviously shown that the odd circle was only developed and eventually formed FZP pattern of amine functional groups, where the other part of surface is covered with PR.

Fig. S3. FZP pattern of streptavidin coated micro-particles (streptavidin-MB)

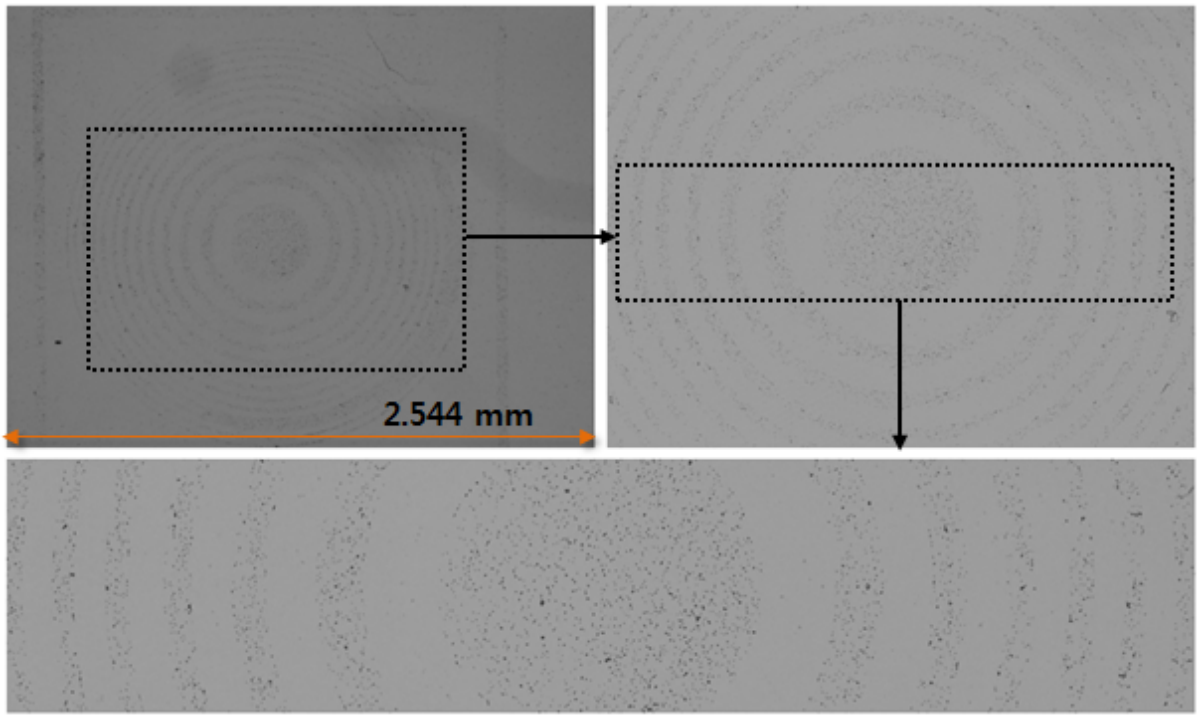
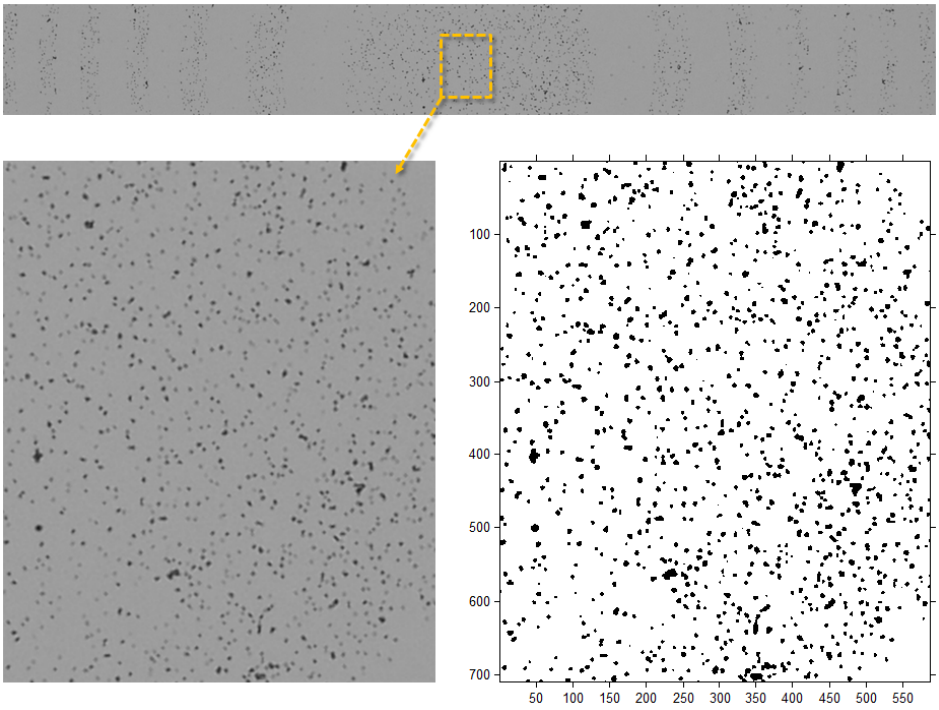


Fig.S3 shows a microscope image of FZP pattern of streptavidin-MB.

Fig. S4. Calculation of packing density of streptavidin-MB



We evaluated packing density of streptavidin-MB across the pattern. In order to calculate the area occupied by streptavidin-MB, we conducted image analysis by using home-made Matlab code. Briefly, we transformed the gray image (raw data, left side) to black/white binary image (right side) and calculated the percentage of black pixels with respect to the entire pixels. It turned out the packing density of odd and even circles was 8.2 % (Std. 0.68 %) and 0.3 % (Std. 0.16 %), respectively. We also present the packing density of each circle.

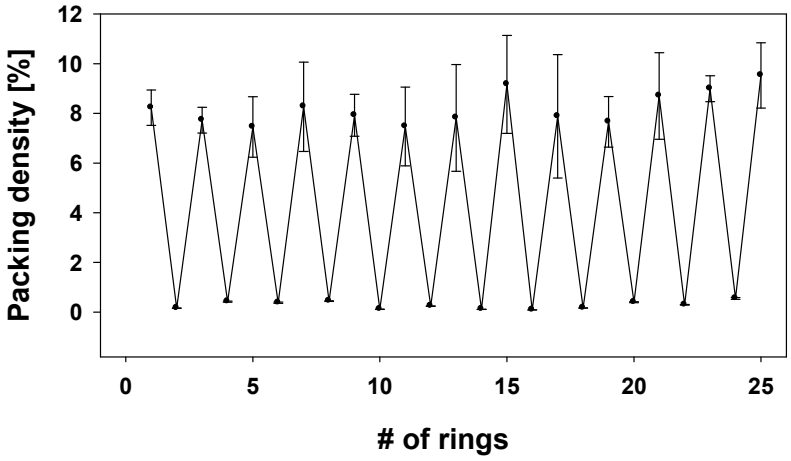
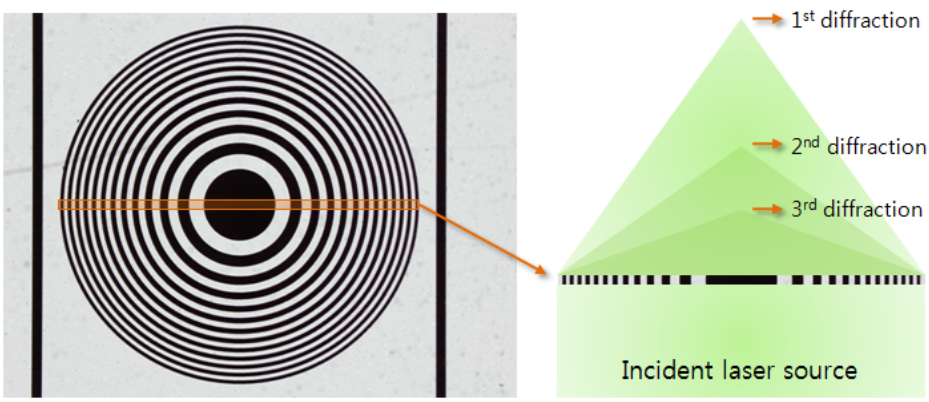
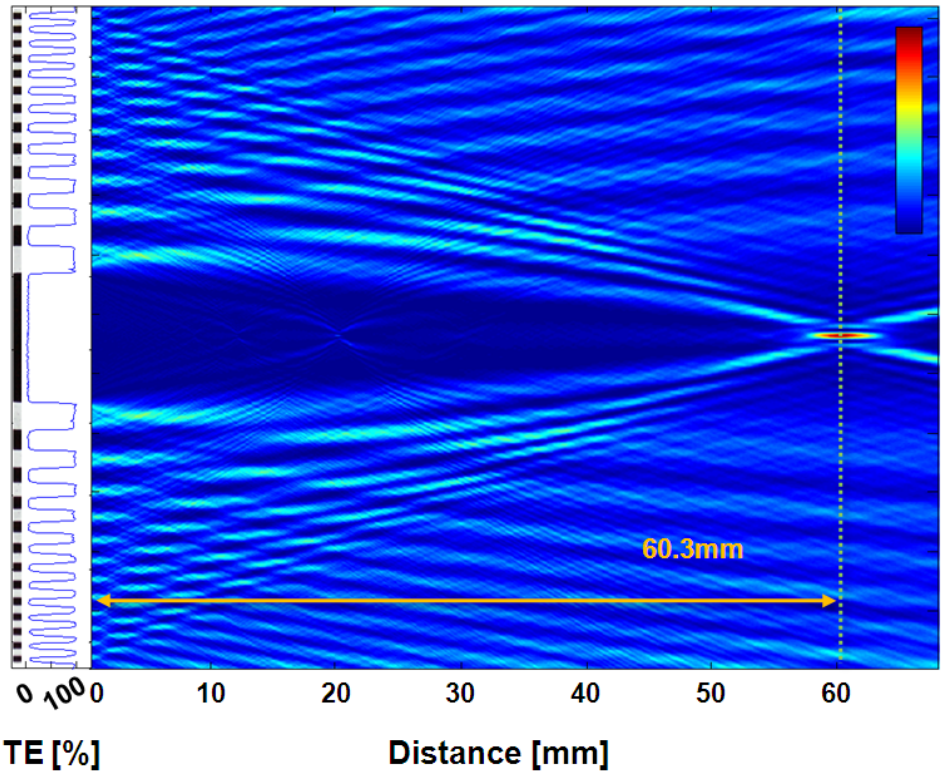


Fig. S5. Semi-theoretical calculation of focal length of FZP pattern

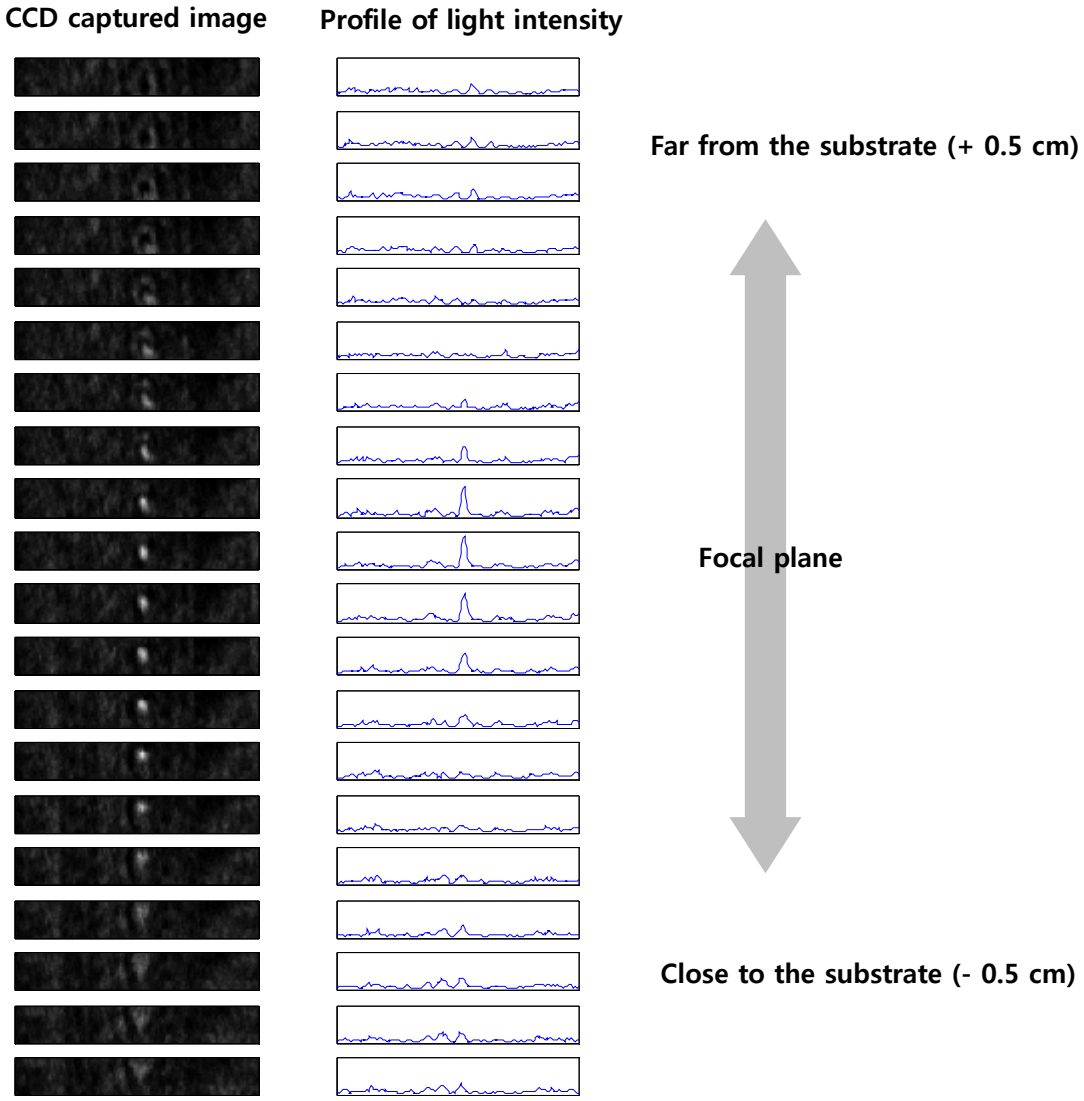


We calculated the semi-theoretical focal length of FZP pattern of photomask through 1-dimensional wave propagation based on Fourier-transform. Monochromatic light source (wavelength of 532 nm) was used.



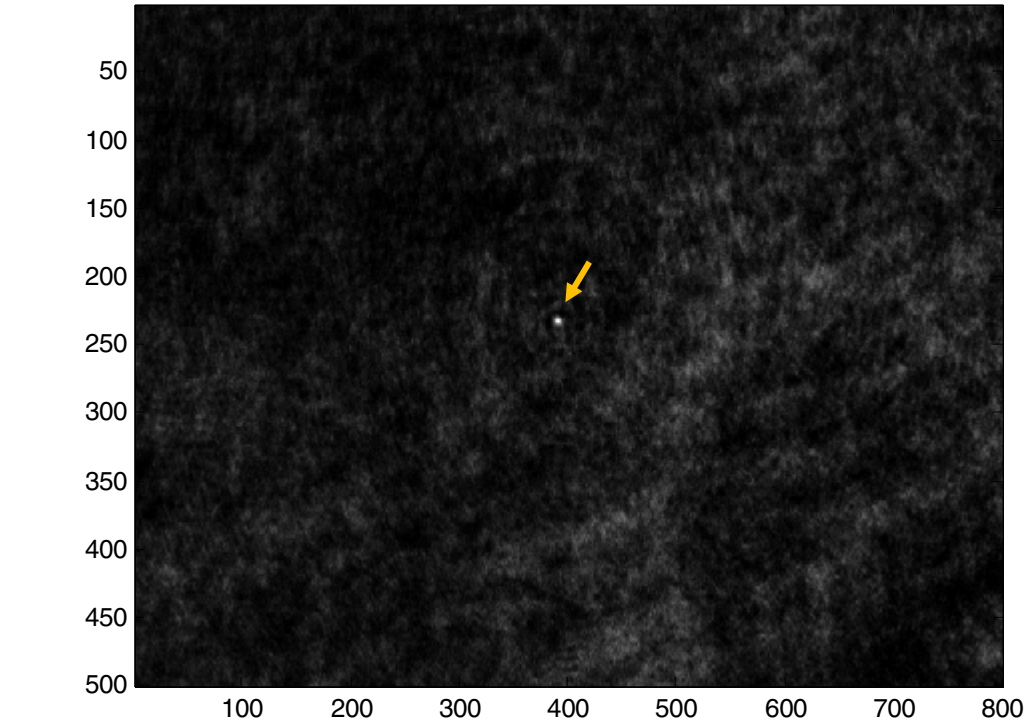
As shown in the figure, light is only passed through the transparent part of pattern and diffracted. The diffracted wave fronts are interfered and converged at a focal point, which is the 1st order diffraction. The simulated focal length is 60.3mm and almost equal to the designed value (60.2mm).

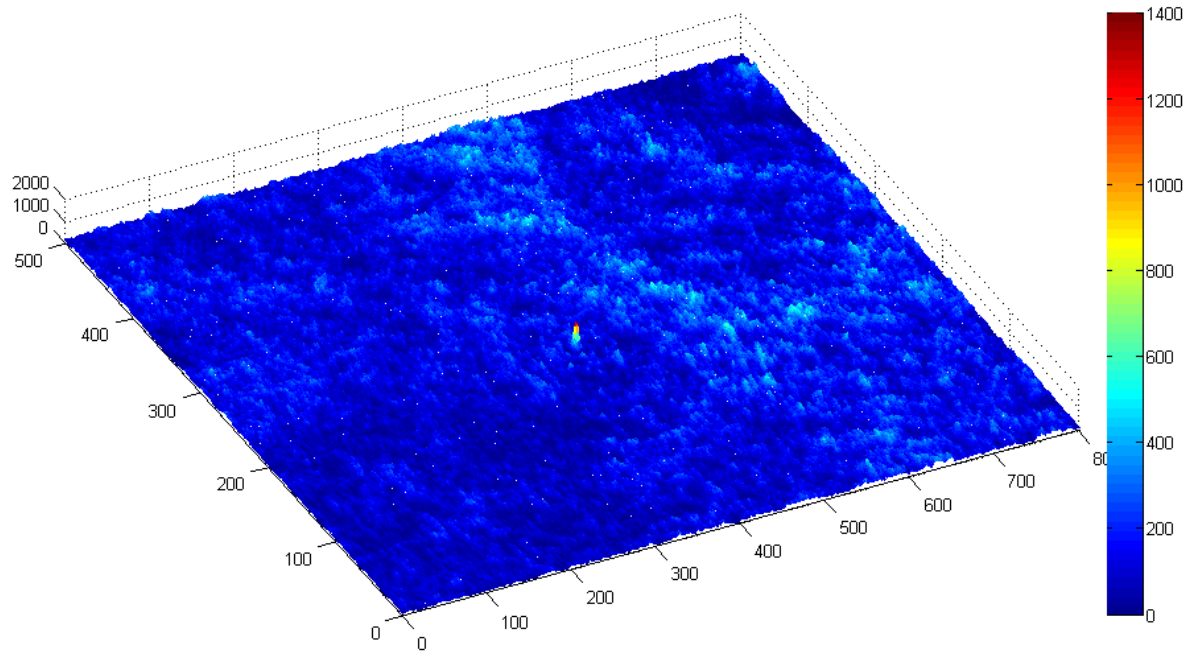
Fig. S6. CCD captured images near the focal point and its profiles of light intensity



We obtained CCD captured images near the focal point by moving up/down the objective lens along the vertical direction. It is obvious that the light was converged at the focal length because of constructive light interference and diverged again.

Fig. S7. CCD captured image at the focal length





The entire image of focal plane is shown. X and Y axis denotes CCD pixels where the single pixel equals 1.875μm. The raw image converted to color-mapped version in order to provide clear view for readers and its color-map scale is shown on the right side.